Eglis

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HOUSTON, TEXAS 77058

REPLY TO
ATTN OF: FS55-71-24

MAR 12 1971

MEMORANDUM TO: FS/Acting Chief, Flight Support Division

FROM : FS5/Apollo 14 AGC Support

SUBJECT : Decisions leading to the solution of the LGC abort discrete problem

1. At about 104:55 GET, we (and other positions having the discrete on a light) noted that the ABORT command discrete into the LGC was zero or ON. This discrete indicated to the LGC that the abort switch was ON. The equivalent discrete into the AGS indicated the switch was OFF. These facts were reported to the Guidance Officer and the MIT/SDL representative in SPAN(MIT). We immediately requested that MIT/SDL ask Cambridge (call sign for the MIT/SDL personnel at the lab) to begin looking into and verifying work-arounds involving the LETABORT flag. Very soon thereafter we concluded that the ABORT and ABORT STAGE discretes could and would be locked out of the LGC by a short (relatively) series of DSKY keystrokes that would knock down that flag. However, since the flag is set at PDI ignition, the DSKY inputs would do no good unless done following ignition. This flag (LETABORT) is the one that actually enables the abort monitor routine (R11) which scans both the ABORT and ABORT STAGE discretes once each $\frac{1}{4}$ second. The routine irrevocably (for descent programs) initiates P70 or P71, respectively. The routine is enabled at ignition (by the aforementioned setting of LETABORT) and the DSKY inputs would serve simply to turn it off. Unfortunately, if the discrete were present during the window between ignition (R11 enabled) and the DSKY inputs (R11 disabled) the irrevocable transfer would result. Under parallel efforts MIT/SDL (and Cambridge) came to these identical conclusions and we all concluded that this procedure should be expanded and detailed, and otherwise made ready for reading to the crew. Several related discussions among involved positions took place. Included were conversations on possible sources of the discrete problem (e.g., switch structure and electronics were investigated), and methods of actually incorporating the procedure into the timeline in such a way that a second PDI attempt could be made if the discrete appeared during the window. Although it was determined that the procedure could be done without actually lighting the engine (to facilitate a second try), the procedure that was finally read to the crew involved nominal ignition but in manual throttle and ATT HOLD. Cambridge was performing verification simulation runs on their hybrid and all-digital facilities all during this period and provided the needed confidence factor.

2. While the LETABORT flag procedure was being finalized and then read to the crew, everyone continued looking for methods to eliminate the window. We rejected as too complex (and too late) one possible procedure that involved literally reprogramming the ignition routine of P63 so that it never set the LETABORT flag. This was the only procedure considered that would have allowed aborting on the PGNCS (until set again, LETABORT completely locks out P70/P71). This procedure is feasible because of the use of tables in all LGC burn programs for sequencing. In essence, an E-memory version of the P63 ignition routine could be substituted for the normal fixed-memory routine by altering the tables in an equivalent way that we do for the LGC deorbit program, P99. Meanwhile another way, besides resetting LETABORT flag, to disable R11 was produced (by several sources as I understand it, although personnel at Cambridge were entirely responsible for finally piecing it together into a workable procedure). It involved setting the software's knowledge of what the current program number is - a cell called MODREG - equal to 71. This effectively locks out R11 because it assumes aborts (e.g., P71) are already initiated and do not have to be started again. The DSKY keystrokes to do this could easily be done prior to ignition, thus eliminating the window. However, setting MODREG to 71 at that time (prior to ignition) has several undesirable side effects that caused us to initially reject it. These are: (1) Throttle up at Tig + 26 seconds is never performed; (2) the descent guidance equations are never started - i.e., no guidance; (3) the wrong weighting factors for some LR data would be used after LR lock-on; and (4) a hardware or software (3xxxx alarm) restart would cause the 71 to appear in the DSKY program register as long as MODREG were 71. In addition, when we first mentioned this as a possible procedure it was getting quite late and some resistance was met for that reason alone.

3. The final procedure was a combination of the LETABORT flag and MODREG methods. Essentially, the setting of MODREG to 71 prior to ignition was used to lock out the discrete until the LETABORT flag could be reset following ignition. Then MODREG was set back to 63 so that LR processing would work properly. Thus, problem 3 (above) was fixed, and problem 4 was judged small because of the relatively short period that MODREG would be 71. Problems 1 and 2 were fixed by manually overriding the auto throttle at Tig + 26 and by setting the flag ZOOMFLG, respectively. Thus, although setting MODREG to 71 eliminated the window, it produced side effects that had to be worked around and it itself had to be removed once the original procedure (resetting LETABORT) was done. Even so, based on MIT/SDL/Cambridge verification runs and recommendation as well as our explaining and pushing for the procedure in a last minute conference in the MOCR, it was decided to read this procedure to the crew.

4. It was read during the last half hour prior to PDI and though the crew misunderstood some minor aspects of its effect, they exhibited superb understanding and patience in accepting a second and last minute procedure, and executed it flawlessly during descent. Needless to say, the ABORT command discrete never appeared during descent. It had appeared, it should be noted, several times again following its first appearance. It was removed the first time by actually cycling the abort

switch. Subsequently, it was discovered that tapping the panel near the switch would remove the discrete. This lead to fears that the vibrations of ullage and ignition would set it and thus greatly contributed to choosing the final procedure to eliminate the window. The discrete appeared at AOS about a half hour prior to PDI just before the final procedure was read up, and not again until during rendezvous when it was just left on.

5. The bulk of the credit for the final implementation of a successful work-around procedure goes to MIT and Cambridge for their excellent work in generating procedures and especially for making innumerable simulator verification runs. However, because the last hours prior to PDI are the busiest in the mission, and because of the great difficulties in getting a last minute complicated procedure off the "drawing board," credit should be given to all involved MOCR and SSR personnel - especially the Capcoms, Guidance Officers, Control - as well as all the other innumerable people in the MCC, Building 45, at KSC, and elsewhere who contributed in some way. Especially for the Guidance Officers and our other AGC personnel, it should be noted that the long and complex normal LGC and CMC timelines for PDI (which in themselves were not without troublesome problems) were completed successfully despite the distractions of the ABORT discrete problem.

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